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## THE LAKES OF THE GLACIER NATIONAL PARK

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By MORTON J. ELROD

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This and subsequent papers by Professor Elrod, to appear during next year, will introduce our members to new biotic conditions,—and to new facts of the distribution of micro-organisms.—[Ed.]

### I.

#### AVALANCHE LAKE

Glacier National Park is in northwestern Montana, on the line of heavy travel. As yet it is visited by a small number of people only. This Park is a wonderland of mountain crags, dizzy cliffs, dashing waterfalls, clear lakes, eternal snow and ice, primeval forest, wild game, blue sky and brilliant sunshine. Here dozens of sharp mountain summits pierce the azure sky, making a ragged saw edge on the horizon in every direction. Here the perfectly glorious heaven's blue is reflected in the unknown depth of glacial ice, or in the mirror surface of placid lakes nestling at the base of frowning cliffs of awful height. Here the works of nature have not been marred by the hand of man. Here is the place where clouds are made; where are seen the largest remnants of that great ice field that in past ages covered all northern America; where ice melts into whispering rivulets which form dashing cascades, these flowing into lakes of wondrous beauty; where exquisitely beautiful landscapes of never ending variety meet the wondering gaze from every direction; where mountains and sky meet and the freshly formed dew glistens in shimmering icicle on the bare rocks or form into tiny droplets which bring life and vigor to the struggling alpine plants. This, indeed, is a fairy land, where dreams of fantastic things come true, and where interest and wonder never cease.

The continental divide in the Park makes a very irregular line as it passes through the quadrangle, alternately pointing to every direction of the compass. This tortuous path is broken by numerous mountain peaks, in part forming the divide, in larger part lying a short distance to one side or the other of the actual watershed. Extending shoulders from the high mountains enclose pro-

tected places. Into these the snows of countless ages have piled by the aid of drifting winds, forming the large ice masses which give rise to the name Glacier Park. Some of the peaks are so precipitous that little snow accumulates, and in late summer are completely bare. This is generally true of isolated mountains.

The mountains of the Park create profound admiration. A few rise above 10,000 feet. Many are between 9,000 and 10,000 feet elevation. Many are below 9,000. Their beauty and impressiveness appears in their abruptness. Their crests seem to have been pushed up out of the earth by sudden upheaval, without the usual long and sloping ridges such as are frequently seen in mountain chains. Precipices from 2,000 to 3,000 feet high are not uncommon, nor can one get out of sight of the frowning cliffs. Geologically they are extremely interesting, and their clean surfaces and clear fractures invite study.

The glaciers of the Park are numerous and easily reached. Of these, large and small, there are about sixty. The size varies from those covering only a few acres up to the largest, Blackfoot Glacier, covering some eight or ten square miles. The glaciers of most interest and importance are Blackfoot, Harrison, Sperry, Pumpelly, Red Eagle, Grinnell, Chaney, Vulture, Rainbow, Kintla and Agassiz. These lie high up on the mountain shoulders, and consist of solid ice, for the most part broken and crevassed, especially noticeable in late summer. The color of the ice is a deep blue, increasing in intensity with the depth. Some of the glaciers are easily reached, others only with extreme difficulty. It is possible to ride on horseback to the ice of either Sperry or Blackfoot. Hundreds of people visit the former annually, as it is the glacier nearest the hotel at Lake McDonald. In fact, it is easily possible to leave the hotel in the morning, spend a couple of hours on the ice at Sperry, and return to the hotel in the evening. To reach Blackfoot glacier requires more time, as it is more remote. But the journey is full of interest every rod of the way, and a visit to Blackfoot means to revel in some of the finest scenery of the Park. Except for the traveler with pack horses the glaciers and other features in the northern end of the Park are not as yet readily accessible.

There are some 250 lakes, large and small, ranging in size from a few hundred feet to 12 miles in length, and of varying width. All the larger lakes are full of fish, and many of the smaller ones

would support fish life, could the fish be placed in their waters. Falls between lakes and in the streams below prevent the ascent of fish, hence their absence from many lakes. The lakes are distributed throughout the Park. From any high summit one may see a number, even as many as 18 or 20 from one point of view.

It is the purpose of the writer to present in this and succeeding articles some of the interesting features, and to give the results of study of the life of some of these lakes. It makes little difference where we begin, hence as a matter of convenience we shall take Avalanche Lake.\*

Avalanche Lake is reached by trail from Glacier Hotel at Lake McDonald. The distance from Lake McDonald is about nine miles. There is no wagon road, and but this one trail, to the lake. The trail is through dense woods, winding over ridges, crossing rivulets, leading through long lanes of waving ferns, always up and up, until the border of the lake is reached.

Our outfit for study consisted of the following articles: a canvas boat; a small dredge made of a rectangular piece of iron 12x8 inches and provided with a net of large mesh next to the iron frame, the closed end of the bag of fine bolting cloth; a thermometer in a brass tube; a set of maximum and minimum thermometers; a set of wet and dry bulb thermometers for humidity determination; two hair hygrometers; cameras and plates; chloroform, alcohol, formaldehyde, bottles, insect boxes, pins, and nets, and dozens of other necessary articles.

Our material, provisions and beds were transported on the backs of seven pack-horses of gentle natures and extensive knowledge of the woods. In addition were four saddle horses, while for lack of other animals two of the party had to walk. The line of eleven horses and seven men winding along the trail through the forest was a fine sight. The bell of the leader gave indication to those in the rear and often out of sight of the progress of the train.

Owing to the difficulties of transportation, the time consumed in making and breaking camp and in attending to other duties, and the difficulties attending visits to lakes with difficult approaches and of caring for and transporting the collections, only a preliminary

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\*The reader is recommended to make purchase of the topographic map, Chief Mountain Quadrangle, which will clearly present the location of this and other lakes. Price five cents in currency. Address the U. S. Geol. Survey, Washington, D. C.

study could be made, and this under trying circumstances.

The visit was made to Avalanche Lake August 4, 1910, the party remaining over two days, spending three nights at the lake. The party consisted of Marcus E. Jones, of Salt Lake City, studying the botany of the region; J. E. Kirkwood, Professor of Forestry in the University of Montana; Walter Lehman, of Lewiston, Photographer; Austin Warr, Lehman's young nephew; the writer, who was making zoological studies, and the guide, T. H. Scott. Each person attended to his own line of study, all the collections being transported by the pack train.

Avalanche Lake lies cradled in the mountains. The scenery on all sides surpasses portrayal by pen, brush or camera. On the north and east an unnamed lofty mountain rises abruptly from the water's edge. On the opposite side the slopes of Mt. Edwards, densely wooded and covered with underbrush, rise with very steep grade to the cliffs near the summit. The rim of Avalanche Basin, on whose top lies Sperry Glacier, forms the remainder of the mountain boundary. Over the precipices numerous cascades and waterfalls come tumbling down to the lake level, bringing the dissolved glacial mud and the disintegrating rock. Practically all of the water of the lake comes from the glacier above. The drainage area is therefore quite small.

The lake is less than a mile in length, elliptical in outline, with densely wooded shores. At the upper end avalanches have swept a portion of the ground clear of trees, for the most part covered with impassable brush. The lake has been filled at the upper end, the meandering streams and comparatively level floor giving ample evidence of this. The old lake bed, together with the material brought down by the avalanche, cover a mile or more of space from the lake to the cliffs.

On this composite soil a composite flora of great interest is found, representing the temperate plants coming up from the lower valleys, as also the alpine vegetation brought down by the snow and ice, some of which is making a desperate struggle for an existence.

The lake is shallow, for a mountain lake, and will doubtless fill in rapidly. A log jam at the outlet effectually prevents the loss of any but the soluble matter from the lake, thus aiding in the deposition of material. Nearly half of the lower portion of the lake

has a depth of only a few feet, from four to ten. At the upper end the lead showed the greatest depth to be 63 feet.

The soundings and dredgings were made from the canvas boat, the first boat of any kind to be floated on the lake. The microscopic life was secured by the dredge. At 9 a. m. of August 4, on the way up the lake, very little microscopic life was found. On the return down the lake at 2 p. m. life was very abundant. The smaller species were at or near the surface in the upper lake, the larger species where the lake was shallow. No attempt was made to gather material from varying depths, as to do so would be impossible. A small haul from the bottom was made where the lake was shallow.

While no deductions can be safely drawn from the observations of one day, yet it seems fairly well established that the microscopic life comes to the surface during the light of the day, descending at night. It is possible they seek warmth as well as light. In Flathead Lake I have seen entomostraca so abundant at the surface on a hot afternoon that they occurred by the dozen in a cup of water dipped up at random.

The color of the water was pea-green, rather murky looking from the sediment coming from the glacier. At 3 p. m. the temperature of the water was 57 degree F; of the air, 70. The percentage of saturation of the air in the woods on the lake shore at 2:45 p. m. was 43, at 3:45 it had risen to 62, and at 6:00 to 83. At night it rose to saturation, and in the morning a light rain was falling. This, however, was local.

The stones at the lake shore in still and shallow water were covered with a light green alga, forming long slender threads, several inches in length. This is a species of *Tetraspora*, found growing also in Lake McDonald. It adheres firmly to the stones, requiring considerable force to separate it from the rock. The plant was most abundant on the smaller pebbles, from the size of a marble to those the size of an egg, and grew most luxuriantly in shallow water of the lake near the inlets.

The widely distributed snail, *Pyramidula strigosa*, so abundant throughout Flathead Lake country, was found sparingly in moist places. It is doubtless abundant in the wet season. There were no snakes. A single frog was taken. One monster toad was observed on the log jam, but slid into the water with a big splash as the net was moved toward it. Two stone-flies were abundant—a gray

species along the creeks, a slate black one over the lake. The former were depositing eggs in the rushing water. Every now and then one was caught by the splashing water, as the abdomen was dipped into the stream, and was carried away—sad ending to an instinctive effort. This was a day flier. The black one over the lake flew only in the dusk of the evening.

The lake is a great place for fish. To use the popular expression, it is full of fish. The most inexperienced fisherman can catch a mess of trout almost any time. In spring and summer the streams carry into the lake an abundance of food. The lake is a small speck in a wide forest area, and great quantities of flying insects fall into it. The myriads of stone-flies make juicy meals, and dozens were taken before our eyes while depositing eggs. A stone-fly falling on the water rarely had more than a few minutes of life after wetting its wings, before it was taken by a fish. The insects for the adult fish, and abundance of entomostracan life for minnows, makes it an ideal place for fish to live. The lake does not have a high elevation, opens rather early in spring, and does not have as long a period devoid of insect food for fish as one would imagine. With the indications of abundance of microscopic life as shown by our dredge it seems possible to keep the number of fish large by continued stocking, even though tourists may come in much greater numbers than at the present. The streams afford abundant protection and shelter for minnows in overflowed and shallow places; and in the inlet streams is the best fishing, especially when insects are flying.

The annual rise of the lake, as indicated by the shore lines, is about three feet. The beach is small and narrow, with fine pebbles for the most part.

To build a road for vehicles from Lake McDonald to Avalanche Lake will require no great engineering skill, and now that the Government has created the Park we may expect roads to be built. This will doubtless be one of the first pieces of road, as it opens up one of the nearest and finest bits of scenery in the Park. It will also open up a fine collecting field for the botanist and entomologist, as well as for the student of general zoology. The wooded mountains are full of rare treasures, now exceedingly difficult to procure because of the trouble in caring for them and getting them safely out of the woods. With our mode of travel most of the time was spent in travel and fixing camps. If we spent a day now and then

PLATE IV.





PLATE V.

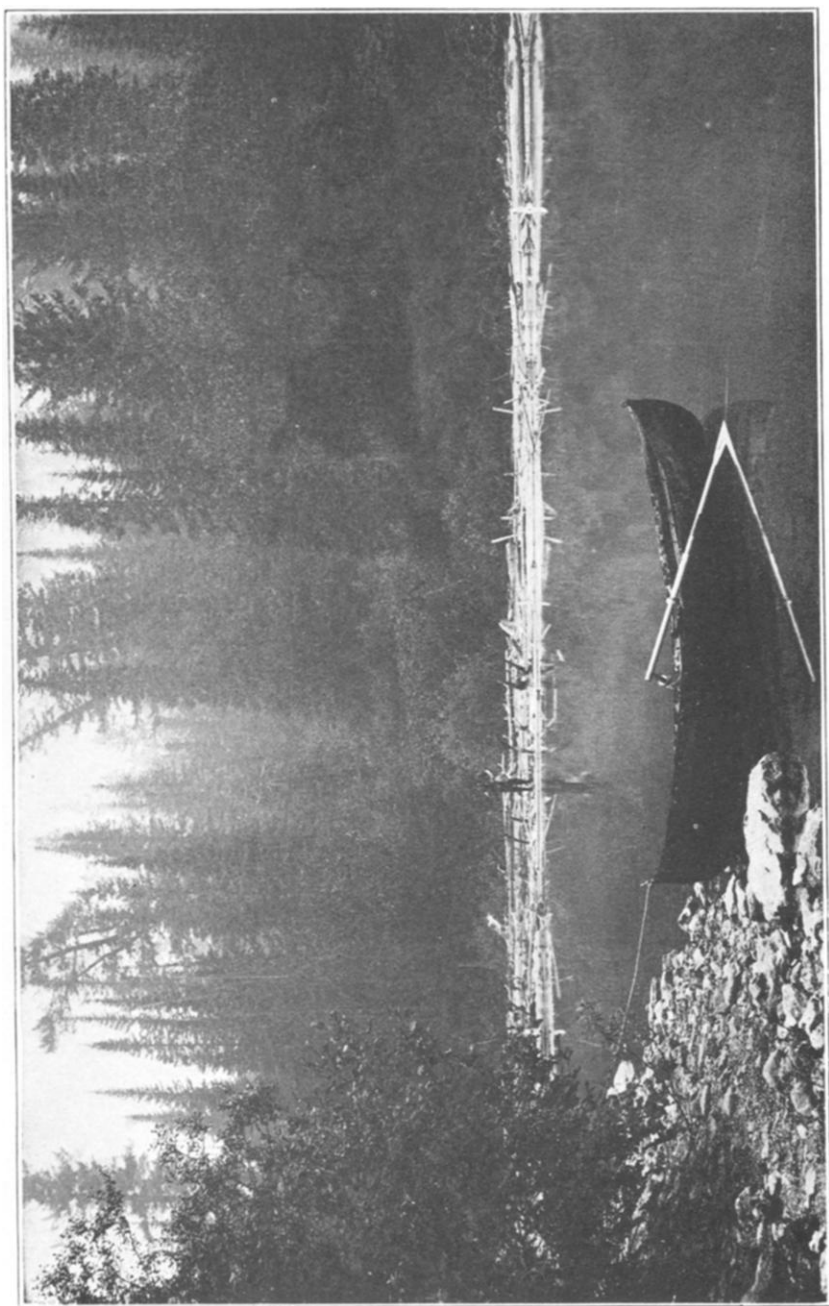


PLATE VI



FIG. 1

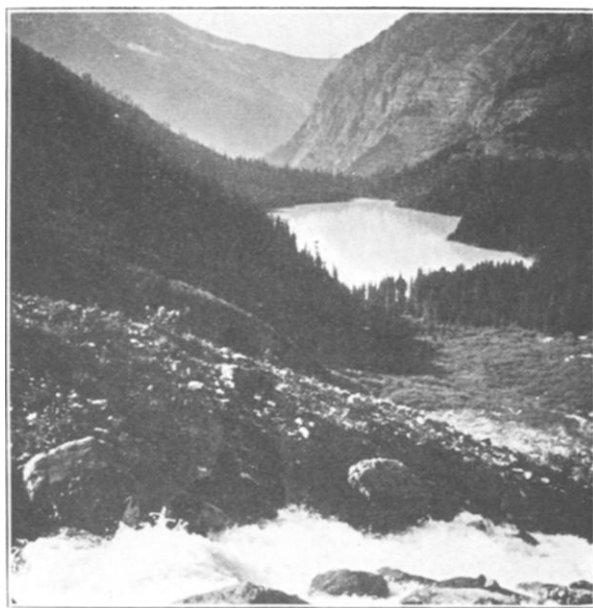


FIG. 2

at a lake collecting microscopic life it could be nothing more than superficial study of qualitative nature, to determine what the country affords rather than to work out a problem.

#### AVALANCHE LAKE STORY ILLUSTRATIONS

Plate IV. Avalanche Lake and Basin from the lower end, showing cliffs above which lies Sperry glacier from which comes the water of the lake.

—*Photo by O. H. Barnhill.*

Plate V. Log jam at lower end of Avalanche lake. —*Photo by Elrod.*

Plate VI, Fig. 1. Gorge in Avalanche Creek, outlet of Avalanche Lake.

—*Photo by N. A. Forsythe.*

Plate VI, Fig. 2. Sperry Glacier, from which comes the water of Avalanche Lake.

—*Photo by Elrod.*